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MOSQUITO CONTROL
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The Durable Mosquito

Mosquitoes are still with us in spite of potent insecticides and a growing array of sophisticated insect-fighting techniques.

Man has waged war on mosquitoes since late in the 19th century yet these pests remain a vexing and often serious problem. They harass man at work and play and hinder the production of livestock and poultry. Some species carry diseases such as malaria and yellow fever to man, encephalitis to man and horses, and heartworm to dogs.

Entomologists who battle this cosmopolitan pest have engaged a many-faceted foe, one diverse in form and habits. About 145 kinds of mosquitoes of some 2,000 species now identified inhabit the United States. Their host preferences and life patterns vary, so that a control method worked out for one species may be futile against another. Some mosquitoes prefer the blood of livestock to that of man, for example, while some species prey on other mosquitoes. Most mosquitoes travel no farther than a mile or two, although a few kinds can fly 15 miles.

To really complicate matters, our best insecticides soon lose their punch against these pests. Thus entomologists do not envision a single major defense against mosquitoes but rather an integrated control approach that combines biological methods with chemical tools.

ARS scientists have pioneered in developing mosquito control methods, including swamp drainage, better irrigation practices, and insecticides. They also developed Deet, the most widely used and effective of present mosquito repellants.

Now they are focusing on new repellents, better techniques for applying pesticides, and ways to enlist allies from among the natural enemies of mosquitoes—parasites, predators, and diseases (pages 8 to 12). Looking ahead, scientists may find ways of exploiting vulnerable points in the mosquito's life cycle to create food shortages, cause exposure to adverse weather, or otherwise force the pest out of step with nature.

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U.S. Department of Agriculture

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PN–1676

Pearl Millet has TWINS

THAT'S THE GOOD NEWS—and one day this blessed event may provide the world with the twin benefits of more and better food and forage.

The discovery of polyembryony in pearl millet, that is, twin or triplet seedlings from one seed, opens the way to new sources of gene pools for improving this crop.

In a 3-year project conducted at Tifton, Ga., ARS geneticists J. B. Powell and G. W. Burton found several types of twin and triplet seedlings in a number of inbred lines of pearl millet.

According to Powell, the discovery of polyembryony in pearl millet will give the plant breeder an efficient screening method for selecting structurally distinct seedlings with a high frequency of deviant chromosome numbers. These seedlings may be haploid, triploid, or tetraploid in chromosome number, although pearl millet is a predominantly diploid species.

By examining these selected seedling pairs (or triplets), the plant breeder may be able to trace the evolutionary pathway by which certain chromosomes have arisen. He may also successfully cross related species that have failed to cross in previous tests.

In their search for polyembryonic plants, the scientists examined field plantings of pearl millet as the plots were routinely thinned each season. By inspecting each seedling in the plots, they obtained a number of twins and triplets.

The scientists also used a greenhouse method of screening that involved planting rows of 100 seeds each in sand-filled flats. Each seedling was examined after emergence, and, when a twin or triplet was suspected, seedlings in that row were dug up, washed, and further examined. The scientists found many twin and triplet seedlings in this way that would not have been visibly distinct from other seedlings had they been simply scanned from above.

In the course of the screening, several million seedlings were examined by one method or another.■

Geneticist R. T. Ramage examines the hybrid barley, Hembar, in a field outside Tucson, Ariz. (PN–1677).

Hybrid Barley . . .
a breakthrough

SMALL GRAINS RESEARCH scored a major breakthrough when a new breeding technique produced the first commercial hybrid of a small grain—hybrid barley.

Athough the hybrid barley is in itself a revolutionary development promising higher yields per acre, the new breeding technique, devised by ARS geneticist R. T. Ramage at Tucson, Ariz., could emerge as the more significant achievement.

Many of our major field and vegetable crops have a genetic makeup similar to barley. This segment, in fact, represents about half the total farm value of the major crops grown. Successful application of the new breeding technique to that segment would greatly increase its total worth.

In field tests at nine locations in Arizona, the hybrid barley, called Hembar, has yielded 15 to 35 percent more grain than Arivat, the main local variety.

Ramage's "balanced tertiary trisomic" (BTT) breeding method makes use of a genetic male-sterile gene, a gene to permit seed sorting, and an extra translocated chromosome made up of parts of two different chromosomes.

The extra chromosome, which provides male fertility and black seed color, is the key to the success of the method. Black seed color is presently being introduced into this system for sorting purposes.

The genes for fertility and black seed color on the extra chromosome must be linked with the breakpoint, which is the place where the chromosomes are broken and rejoined after changing partners. The corresponding genes for male sterility and white seed color are located on the normal chromosomes.

This technique produces two types of seeds, occurring in a 70 to 30 ratio. The 70 percent are male sterile; the 30 percent are fertile and BTT—that is, they contain the extra chromosome. At this phase of the operation, all seeds are black.

When these seeds are grown and pollinated by BTT plants, they produce two kinds of plants: 70 percent of which are male sterile, normal, and white-seeded; 30 percent of which are fertile, BTT, and black-seeded. The plants are harvested in bulk, and later the seeds are sorted by color.

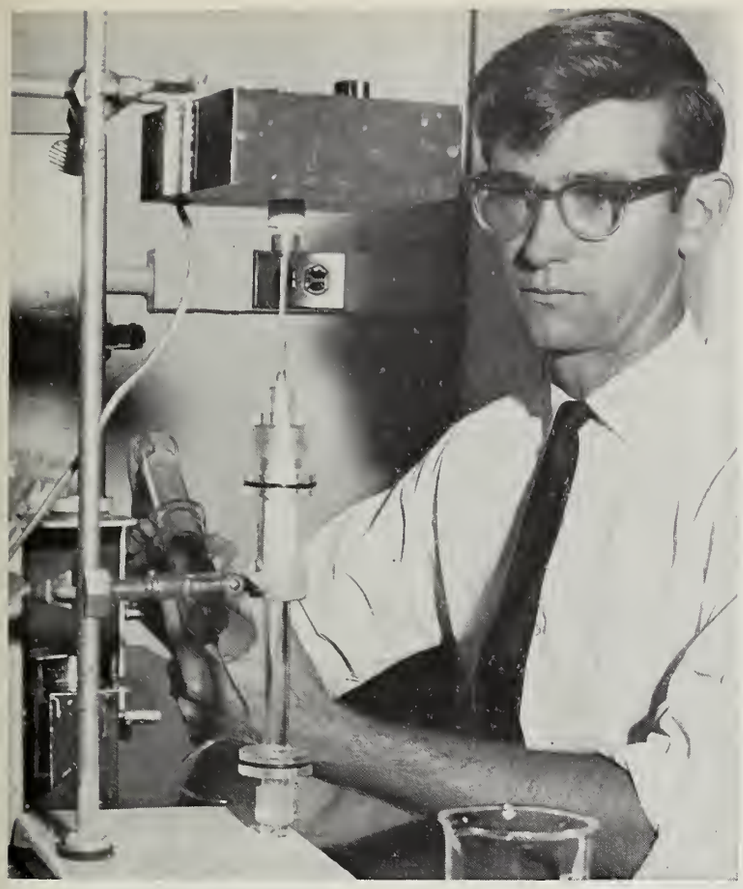
The black plants (fertile, BTT, and black-seeded) are identical to the original starting plant and can be used to repeat the BTT cycle.

The white seeds are planted between rows of a male parent having good combining qualities to give a vigorous hybrid. In the Arizona experiments, the male parent was Arivat. The two parent rows cross-pollinate to produce seed for the farmer.

A big advantage of Ramage's method is that it bypasses seed losses caused by incomplete fertility restoration, which can cause difficulties in the cytoplasmic method, currently the most common way to produce hybrids.

A most important step in achieving a hybrid is the production of crossed seed. Under Arizona conditions, results ranging from 30 to 80 percent of maximum seed set were obtained.

More research is needed to develop hybrid barley for other regions of the United States and the world, and to produce hybrids of other principal crops. Nonetheless scientists find prospects encouraging in view of these recent achievements. ■



Left: Virologist R. E. Davis prepares one of the steps in isolating the causal agent of aster yellows disease (PN–1678). Below: New growth and flowering of aster plant on the left followed treatment. Plant on right is untreated (PN–1679).

Antibiotics Curb Plant Disease

ANTIBIOTICS THAT CURE pneumonia in human beings will also suppress a serious plant disease.

In addition, the discovery that this disease, aster yellows, is probably not caused by a virus, upsets a long-held scientific assumption and opens the way to understanding and control of the disease.

These findings, by a team of ARS scientists, have raised the hope that presently known antibiotics may be used effectively in the battle against aster yellows and similar diseases of vegetable and fruit crops and ornamental plants. The research team includes virologist R. E. Davis, entomologist R. F. Whitcomb, and R. L. Steere, leader of the Plant Virology Pioneering Research Laboratory at Beltsville, Md.

Scientists had not tested antibiotics on aster yellows and similar diseases because of the generally held belief that such diseases were caused by viruses and would therefore not respond to antibiotic treatment.

However, work done by Japanese scientists on a mulberry disease led the ARS scientists to suspect that aster yellows was really caused by "Mycoplasma-like" organisms similar to those responsible for diseases in man and warm-blood animals.

Following up this lead, the scientists ran tests at Beltsville, Md., using thousands of plants and found that the disease could indeed be successfully treated by the same antibiotics used to treat diseases of man.

The well-known antibiotic drugs chlortetracycline (aureomycin) and chloramphenicol (chloromycetin) were applied, in different tests, to roots and leaves of plants. The scientists found that root application was much more effective than leaf application.

When treated with an effective antibiotic, plants showing severe disease symptoms produced new, healthy leaves and flowers. When plants were taken off the drugs, however, symptoms reappeared 3 or 4 weeks later.

Although more research is necessary, there are many possibilities for the practical application of antibiotic treatment of aster yellows and similar diseases. Antibiotics might be applied to save a season's fruit crop should it be seriously threatened or to save valuable specimen plants. After successful treatment, the new growth could provide disease-free cuttings, grafts, or seeds.

Finally, these new clues to the identity of the elusive aster yellows pathogen may lead to finding better antibiotics to combat aster yellows and similar diseases. ■

Batch Pasteurization

System for small-volume liquid egg producers

A "MINI" PASTEURIZER and process has been developed for small-volume producers in the liquid egg industry.

The new equipment, an ARS-University of California cooperative effort, costs less than $12,000.

Over 66 billion individual shell eggs are produced in the United States each year. Most are destined for table use, but many don't make it, particularly those that are too small, cracked, thin-shelled, or of low interior quality. These eggs, slightly over 14 percent of the total produced, are marketed as liquid egg products for commercial users such as bakeries and noodle and mayonnaise manufacturers. Under the USDA voluntary egg products inspection program, all egg products must be pasteurized, and several States require that they be free of *Salmonella* bacteria. The most popular *Salmonella* treatment is pasteurization.

Until this year, only HTST (High-Temperature Short-Time) type pasteurization developed by the USDA was used. Equipment available was designed for operations involving several hundred gallons or more of liquid egg per hour, and required more than $25,000 in capital investment.

Small-volume producers, concerned with only a few hundred gallons or less a day, account for about 2 percent of the liquid egg product industry's output. They could neither use HTST efficiently, nor could they justify the large investment. Although some of them relied upon large plants for pasteurization, many weren't located close enough to warrant transporting their liquid eggs to the plant.

This segment of the industry needed a batch (small volume) process that reduced bacteria as effectively as HTST, and which caused minimal damage to the functional properties of liquid eggs. The process would also have to be adaptable, both in cost and capacity, to the requirements of small-volume producers.

The researchers tested four pasteurizers: one laboratory-built and three commercial units. The laboratory-built unit consisted of a 3-gallon stainless steel bucket surrounded by a water bath that could be heated and cooled at a wide range of temperatures and time periods. An electrically-driven impeller for agitation was mounted on the cover.

The second unit was a 50-gallon kettle with side-wall heating and cooling and swept-wall agitation. The third was a 130-gallon kettle with side- and bottom-wall heating and cooling and impeller agitation. The fourth was a 100-gallon horizontal kettle with rotary coil heating and cooling. Both the 130- and 100-gallon units were modified to include head-space heaters to assure pasteurization of surface foam.

The batches of liquid whole egg were inoculated with *Salmonella typhimurium*. Samples were drawn for functional property tests and *Salmonella* kill rates at various intervals during heating, holding, and cooling.

Each of the commercially-available pasteurizers. after minor modifications, produced satisfactory results. A major factor in the process is the proper application of time and temperatures. Researchers concluded that a batch process utilizing a heating time of about 30 minutes and a hold time of 10 minutes at 135° F. for liquid whole egg controlled *Salmonellae* as adequately as the time and temperatures specified for HTST processes.■

The laboratory-built, 3-gallon pasteurizer. The left rod in the liquid egg carries the impeller for agitation; the other records the temperature (ST–738–5).

Lindahl fills homemade milk dispenser as technician Dale Harper holds lamb. Lambs had to be taught to drink from dispenser, but after learning the trick, they resented further lessons from handlers and drank throughout the day (ST–3684–12).

ICE-COLD MILK

Saves orphan lambs

ORPHAN LAMBS CAN be raised on an ice-cold milk formula fed by a dispenser filled only once a day.

At Beltsville, Md., some 90 percent of lambs started on the cold formula survived to weaning, compared to a survival rate of 80 percent for lambs reared naturally. The lambs gained 0.8 pounds per day on cold formula, compared to 0.6 pounds normal daily gain.

Commercial sheep producers need a milk replacer since some lambs are left without an adequate natural milk supply because their mothers die, fail to lactate properly, or get behind milk requirements of multiple lambs. Current breeding research aims to produce more multiple births, so the feeding of milk replacers is bound to grow.

Lambs at Beltsville were started on the cold formula at ages ranging from 1 to 10 days, but they did best when they got at least 2 days of natural colostrum. It took 3 days of hard work to teach lamps to feed at the dispenser. I. L. Lindahl, ARS sheep nutritionist in charge of the project, says that each lamp required at least four lessons per day.

The key feature of the new method is refrigerating milk to near 32° F. before serving the lambs. At this temperature, bacterial growth in the milk formula is retarded enough to prevent digestive upsets. Furthermore, cold milk keeps lambs from overdrinking. Big gulps set even the sturdiest lambs ashivering—so they quickly learn to take small sips throughout the day.

Lambs were fed in two or three age groups to keep older ones from crowding younger penmates away from the dispenser. They were weaned abruptly when 60 days old.

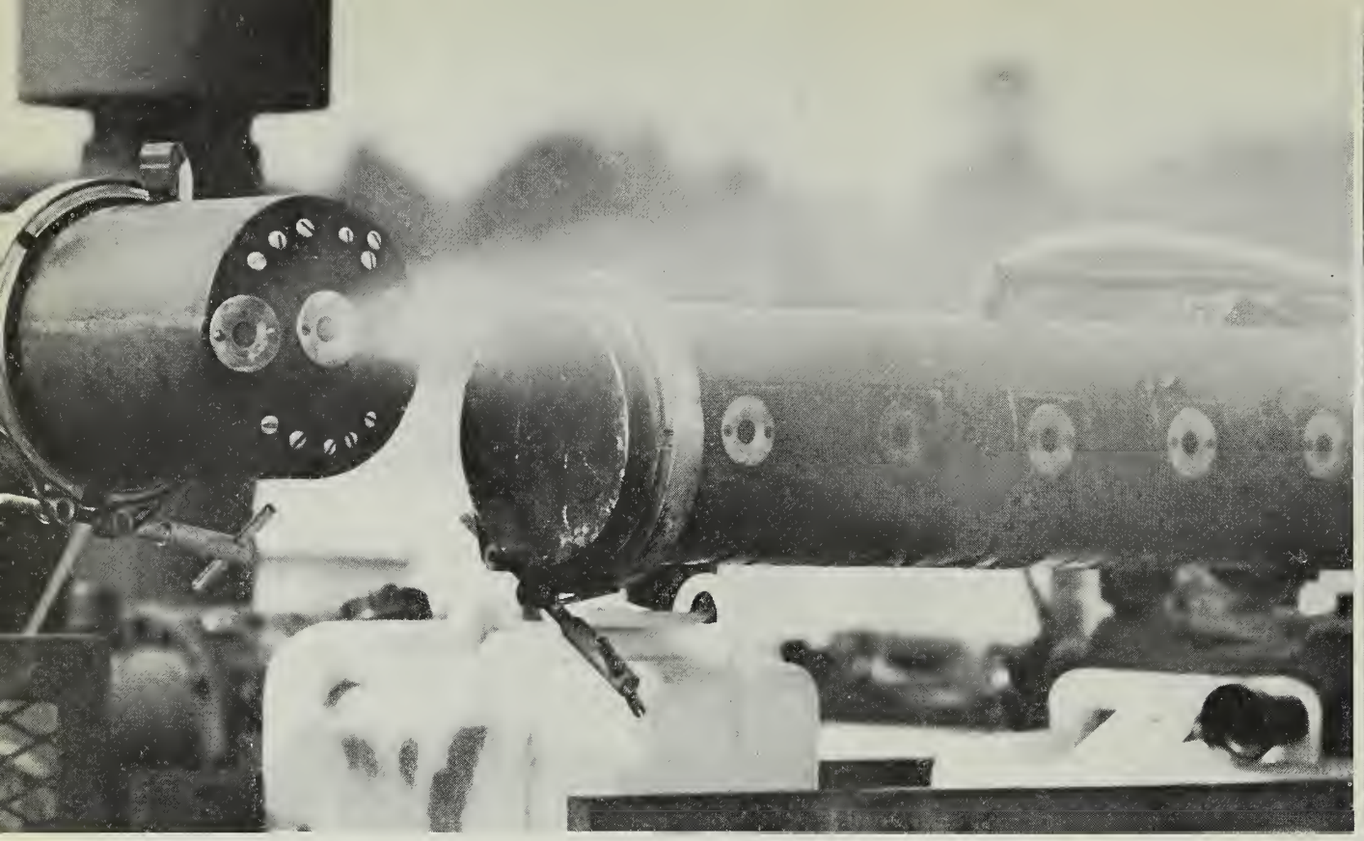
Abrupt weaning caused no ill aftereffects, as the lambs had become accustomed to solid feed while on the dispenser. Slow weaning—tried with a few lambs—resulted in overdrinking and digestive problems, Lindahl says.

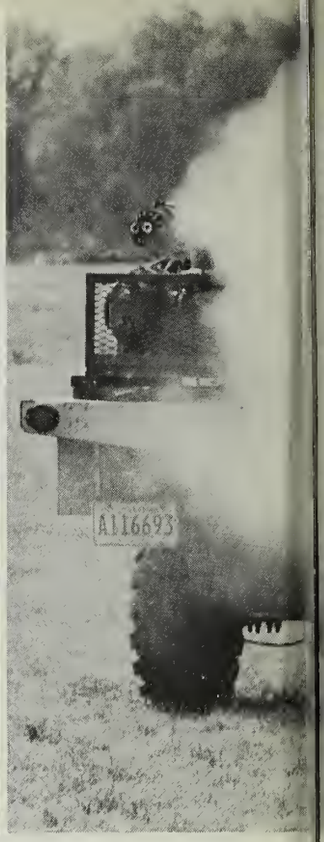
Researchers built the dispenser after European scientists first tried the idea of feeding cold milk. The ARS men grafted nipples from commercial feeding pails onto large, square polyethylene boxes with lids. Long plastic "straws" lead from the nipples to the bottom of the dispenser.

Lindahl's staff made up milk formula daily by mixing 20 parts of commercial milk powder with 80 parts water. The powder, an Irish import, duplicates the proportion of solid nutrients found in natural ewe's milk.

Studies on feeding orphan lambs at Beltsville followed earlier work at the U.S. Sheep Experiment Station, Dubois, Idaho, where lambs received warmed cow-milk replacer from commercial calf nursing machines. Under conditions there, survival averaged 70 percent and daily gains 0.47 pounds.

That was an improvement over usual results with bottle-fed lambs, at a considerable saving in labor. At Dubois, up to 25 lambs shared each nipple on a milk dispenser without excessive competition, a finding also thought applicable to the new cold-milk feeding system.■





MOSQUITO INSECTICIDES *Better m*

INCREASING RESISTANCE TO insecticides by mosquitoes threatens to limit the time we can control these pests with existing products. To meet this threat, ARS entomologists are looking for better ways to use present insecticides while testing promising new materials.

Malathion—the most widely used insecticide—began losing its punch against mosquitoes in 1956, after only 2½ years' use (AGR. RES., May 1957, p. 16). At least 12 kinds of mosquitoes are now resistant to DDT in various parts of the world, and 34 are resistant to dieldrin, reports J. B. Gahan, at the Insects Affecting Man and Animals Research Laboratory, Gainesville, Fla.

About six kinds of mosquitoes are resistant to some insecticides in the United States. Increasing resistance of mosquitoes to insecticides may be offset, at least in part, by more effective methods. Ultra-low-volume (ULV) applications, for example, proved better than conventional treatments in tests by G. A. Mount and C. S. Lofgren, also at Gainesville. Naled in a ULV spray controlled 95 percent of the salt-marsh mosquitoes in one area within 30 minutes. Conventional naled aerosol sprays gave only 74 percent control.

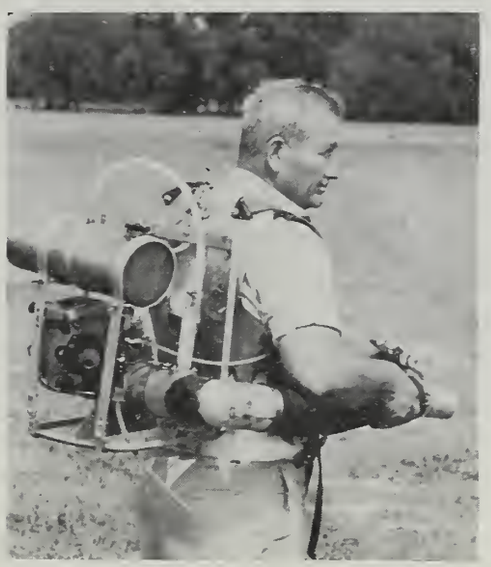
In other experiments by B. M. Glancy cooperating with the Brevard County (Fla.) Mosquito Control District, a ULV mixture of 1 ounce of naled and 4 ounces of malathion per acre killed 97 percent of the salt-marsh mosquitoes in both light and dense foliage in a 50-acre citrus grove.

In 1966, good results with ULV sprays at a rate of 3 ounces of insecticide per acre were obtained in a 475,000-acre area. The area was treated under the direction of the U.S. Public Health Service to end an outbreak of sleeping sickness in Dallas, Tex.

Along with greater effectiveness, ULV sprays offer other practical advantages over conventional sprays: They cost less and reduce the number of times tanks must be refilled. For example, Mount and Lofgren killed mosquitoes with 6 ounces of material per acre applied in a ULV spray, compared to 3 quarts of insecticide in a conventional spray.

These two scientists also found that newer aerosol equipment, called nonthermal or cold foggers, are as effective against mosquitoes as the older thermal fogging equipment. Thermal foggers atomize insecticides with blasts of hot air or steam; cold foggers operate on the principle of air atomization at a low pressure and high volume using special nozzles. Cold foggers produce a less dense fog, so that the vision of operators is less likely to be obstructed. This is especially important when the fogger is operating on a moving truck or tractor along streets or in a grove of trees.

Cover: Mosquito bites into an unprotected arm (PN–1680). Left: The fine mist sprayed from ultra-low-volume apparatus in left photo contrasts with the normal spray of insecticide seen in right photo. The conventional fogger has nozzles on the side of the cylinder and can be modified for ULV spraying by using special nozzles shown on the end. Both units are mounted on the truck (ST–3739–13; ST–3739–3).



Left: Technician K. F. Baldwin experiments with back-mounted ULV fogger (BN–31995).

Below left: Technician changes tips on spray nozzle to regulate fineness of spray for aerial tests (ST–3740–14). Top: Airplane dispensing insecticide flies by pole on which test pads are mounted at different heights to record the amount and dispersal patterns of spray (BN–31991). Bottom: Mosquitoes are placed in cylindrical screened cages mounted on a tall pole for testing spray. Board on far side of cage is treated with dye to record dispersal patterns. (ST–3738–4)

ods and materials

Promising new insecticides are also given trials at the Gainesville laboratory. About 20,000 materials have been tried in the last 25 years, of which only a small fraction showed promise.

In one series of experiments, the Gainesville entomologists killed 95 to 100 percent of common malaria mosquito larvae with insecticides made from the roots and stems of a thistle and a fern. However, the most promising materials tested in the last 4 years were manufactured products rather than plant derivatives.

Good results with experimental pest killers obtained by ARS entomologists are encouraging but they are only part of the exacting standards that insecticides must meet before they can be offered to the public. Their effectiveness and safety must be demonstrated under varied conditions; manufacturers must then clear the insecticide products with appropriate government agencies.■

Covered plastic boxes with screen at bottom and sides contain mosquito larvae and are placed to survey the presence and infectivity of diseases and parasites in a selected area (PN–1681).

parasites and diseases Play a part in

Mosquito larva fatally infected with nematode which is coiled around the insect's thorax (PN–1682).

MOSQUITOES NOT ONLY carry diseases of man and animals but are themselves prey to parasites and diseases that infect and kill them. ARS scientists are seeking ways to exploit these allies for biological control. Initial studies look promising.

At least 30 mosquito species are now known to be parasitized by nematodes, microscopic roundworms. Of these 30 species, 17 have been identified since 1960 in intensified research on ways to control insects with biological agents.

In Louisiana, ARS entomologists H. C. Chapman, J. J. Petersen, and D. B. Woodard recently found that the nematode *Agamomermis culicis* may be potentially useful in controlling salt-marsh mosquitoes, major pests in many Eastern and Southern coastal areas.

Not only does *A. culicis* limit its attack to salt-marsh mosquitoes, but its life cycle is ideally suited to that of its host. Both the nematode and mosquito hatch from their eggs when marshes are flooded; the nematode then penetrates the mosquito larvae, which live in the water in this stage of their lives.

When infected mosquitoes reach adulthood, the nematodes burst out of their hosts to mate and lay eggs, killing the mosquitoes as they emerge. The entomologists also found that the nematodes produce beneficial effects even before they kill the mosquitoes; Infected female mosquitoes are unable to produce eggs.

In addition, the mosquitoes are not killed before they have carried the parasites to widespread mosquito-breeding areas. Another kind of nematode—*Romanomermis* species—kills mosquitoes in the larval stage, one possible reason why these nematodes are less widespread than *A. culicis*.

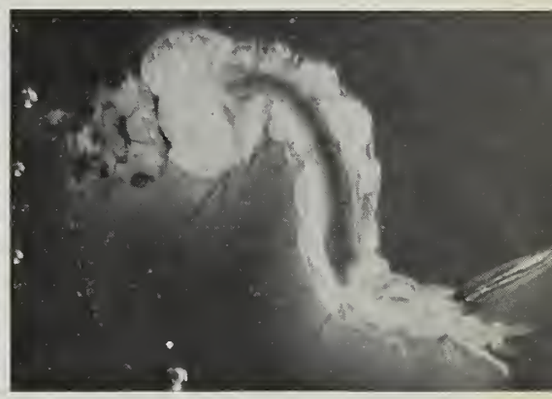
Of more than 2,300 adult female salt-marsh mosquitoes examined throughout Louisiana, ARS entomologists found that an average of 17 percent were infected by *A. culicis*. In some areas, however, up to 91 percent of the females were infected.

Related laboratory tests confirmed the entomologists' field studies: Infected female mosquitoes did not develop normal ovaries and were unable to produce eggs. Of 32 infected mosquitoes observed in one series of experiments, 21 died when the nematodes burst out of their hosts' bodies. Only four of the survivors lived long enough to bite anyone and to subsequently develop and lay their eggs. Moreover, these mosquitoes laid an average of only 69 eggs—less than half the number laid by normal mosquitoes.

Further laboratory and field studies may show whether these particular kinds of nematodes affect higher forms of life, including man and animals. The possibilities for producing the nematodes and releasing them to increase their natural control of mosquitoes must also be determined.

FUNGUS DISEASES KILL at least 18 species of mosquitoes, including 10 found in recent field studies by Chapman and his associates. Although fun-

Left: White specks in mosquito larva's thorax, the bulging part of the body, are fungus reproductive tissue which is produced in enormous amounts (PN–1684). Right: White, swollen areas of infection in this mosquito larva indicate protozoan disease (PN–1685).



mosquito control

An adult mosquito is killed by nematode as it bursts from the insect's body (PN–1683).

gus diseases of mosquitoes are not widespread, they are effective where found.

Chapman and entomologists T. B. Clark, Petersen, and Woodard found that the most important fungus disease—caused by the *Coelomomyces* species—infects an average of 57 percent of malaria mosquitoes in some locations. They say this is a high rate of natural control.

In some places, infections ran as high as 93 percent. However, larvae of salt-marsh mosquitoes had an infection incidence of less than 1 percent.

In nature, *Coelomomyces* fungi live in the water in which mosquito larvae develop. Although the mode of infection has not been determined, entomologists found that the body cavities of infected larvae become packed with sporangia, the reproductive tissue of fungi.

In field studies, the entomologists easily distinguished healthy from diseased mosquito larvae, which were discolored, stunted, and often swollen before they died.

If ways can be found to rear the *Coelomomyces* fungus in the laboratory and to artificially spread it in mosquito breeding areas, its natural effectiveness might be increased.

McNeese State College, Lake Charles, La., is cooperating in ARS experiments with the nematode and fungi. Ways to produce the fungus on a large scale in the laboratory are being studied by the University of Florida under an ARS contract.

PROTOZOANS MAY BE the largest group of parasitic diseases of mosquitoes, reports ARS entomologist E. I. Hazard, Gainesville, Fla. Spores of these microscopic organisms enter the bodies of mosquito larvae with food, water, or air and germinate in the insects' digestive tracts. Chapman's laboratory studies in Louisiana indicate the spores then spread through their hosts' bodies. Mosquitoes that survive may transmit the disease to future generations through their eggs.

In related studies, Chapman and his associates captured more than 3,000 mosquito larvae infected with virus diseases in widely separated areas of Louisiana. Survivors of sublethal infections may spread the disease; moreover, decomposition of dead, diseased larvae releases virus particles to cause further outbreaks.

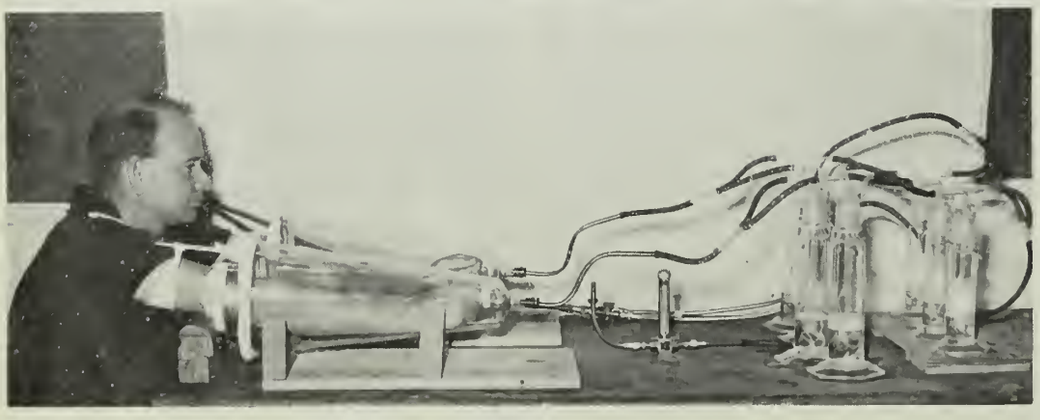
In another approach to biological control, scientists are studying the potential for using fish that eat mosquito larvae and pupae. Under a contract with ARS, entomologist E. C. Bay, of the University of California at Riverside, is studying the effectiveness of fish imported from South America and Africa.

The imported fish have unusual potential because their eggs withstand extended droughts and hatch in large numbers with each flooding. Apparently, native American fish used for mosquito control require annual restocking in seasonal accumulations of water and often take too long to reproduce to densities that will control the pests.■

New repellents KEEP MOSQUITOES away

NEW REPELLENTS TO keep mosquitoes at a distance are showing promising results.

The experimental repellents extend their protection beyond the site of application and therefore might prove ideal for use on hat visors, collars, or mosquito netting. They also show promise for use on tent and window nettings. Applications on clothing instead of skin are not only more comfortable but they last longer, thus cutting costs and frequency of application. The greater ventilation possible by using a coarse mesh netting treated with repellent instead of a finely woven netting is another comfort factor.



Entomologist H. K. Gouck, stationed at Gainesville, Fla., and chemists T. P. McGovern and Morton Beroza at Beltsville, Md., conducted the tests using netting with ¼-inch openings—large enough for good ventilation, but also for the hungriest and meanest mosquitoes to pass through easily.

Of 535 experimental repellents. the scientists found 12 that held yellow-fever mosquitoes at bay for more than 100 days. The mosquitoes were experimentally repelled by the most effective of these materials for 266 days.

Deet, a repellent developed several years ago by ARS scientists (AGR. RES., March 1957, p. 6), is very effective against mosquitoes, lasting for more than 49 days when applied to clothing, but does not show the desired degree of space repellency.

Safety of the best experimental repellents, their effects on various kinds of fabrics, and the protection they provide under different conditions of use will be determined in further research.■

Left: A researcher demonstrates how quickly mosquitoes attack unprotected arms. Repellents now on the market only keep mosquitoes from biting into the treated areas; the insects find the untreated spots (N–52322). Below: Equipment for collecting repellent lost by evaporation. Such tests indicate how long an application will remain effective (PN–1686).

Technician at left sends washed potatoes through the lye tank, a piece of equipment also used in conventional potato peeling processes. Behind the other operator is the perforated drum where the potatoes are tumbled under infra-red burners (PN–1687).

Experimental POTATO PEELING PROCESS

. . . Designed to cut stream pollution

A POTATO PEELING process under development promises to help potato processors comply with strict new Federal pollution regulations.

In tests, the experimental ARS process kept up to 75 percent of a processing plant's organic waste matter and nearly all the caustic used for peeling out of the effluent, greatly simplifying the job of treating effluent before it is discharged into streams.

Potato processing plants produce huge amounts of water polluting substances. Most of the pollutant is settled out in a primary treatment. The effluent from the primary treatment is further treated to reduce its biochemical oxygen demand (BOD), then it is discharged. Wastes with a high BOD deplete dissolved oxygen in streams and are serious pollutants. A new law will soon require potato processing plants to reduce effluent BOD to much lower levels than possible with most present facilities.

About 80 percent of the processing pollution load is from the peeling operation. Most plants now remove peels with high-pressure sprays after the peels have been softened by steam or a lye solution. A large volume of wash water containing the peels goes into the water-treating facility. ARS research has therefore concentrated on ways to remove the peel without high-pressure water sprays.

In the experimental ARS system, called "dry" caustic peeling, potatoes are not preheated, which is the customary practice. Instead, washed potatoes are sprayed for 50 to 100 seconds with a 20-percent lye solution at 170° F. After draining briefly, the potatoes are held at room temperature for 5 minutes, then tumbled in a perforated drum for 2 to 5 minutes under gas-fired, infra-red burners which radiate 1600° F. heat.

During this tumbling, from one-half to two-thirds of the peel is removed; the rest is removed by rotating rolls covered with rubber or neoprene matting from which extend many flexible "fingers" one-half inch long. After this treatment, the potatoes are brush-washed with water to remove the small amount of softened tissue remaining. The potatoes are then ready for processing into the desired products.

Since water spray is not used to remove peels, the peel wastes can be kept separate from other water-borne wastes, which flow to the waste-treatment facility. The separation of peeling wastes keeps 75 percent of all waste out of the waste-treatment process, thus reducing costs by leaving only 25 percent to be handled conventionally.

Organic matter in the peel waste from the ARS process can be destroyed by burning, or it could probably be treated and used in mixed feed for cattle.

One phase of current studies deals with removal of scar tissues from damaged and diseased areas, which becomes more difficult with time in storage. Stored potatoes representative of those used in commercial processing are also under study, and processing steps are being modified to accommodate quality changes that occur during storage.

The work is being conducted at the ARS Western utilization research laboratory, Albany, Calif., by engineers R. P. Graham, C. C. Huxsoll M. R. Hart and A. I. Morgan, Jr., and plant physiologist M. L. Weaver.■

Above: The experimental harvester (PN–1688). Below: Field of recumbent sugarcane burned to remove trash and ready for harvest (PN–1689).

Recumbent Sugarcane

. . . soon Machine - Harvested

RECUMBENT SUGARCANE THAT has grown into a tangled mass can be harvested mechanically.

ARS agricultural engineers J. E. Clayton and H. C. Whittemore at Belle Glade, Fla., are developing cutting, chopping, and cleaning devices for the economical machine harvesting of such cane.

Most sugarcane in Florida, Puerto Rico, and Hawaii is recumbent because the high growth rate and long growing season—2 years in Hawaii—cause the stalks to fall and tangle. In Louisiana, where cane is harvested annually, hurricanes may tangle or blow the sugarcane flat.

Such sugarcane is almost always hand-harvested in Florida and Puerto Rico because present harvesting and cleaning machinery is costly. But American growers, faced with the increasing cost of labor and a possible labor shortage in the future, may be forced to turn to mechanical harvesters.

A harvester for recumbent sugarcane must cut the stalks, part the overgrown rows, chop and clean the otherwise unmanageable stalks, and convey the pieces to a transport bin. In contrast, mechanical harvesting of upright cane involves only cutting the stalks at the base, cutting the immature tops, and windrowing the stalks in the field for loading.

Clayton and Whittemore mounted their harvesting and cleaning devices on a 4-wheel-drive tractor. Plant lifters start the stalks into the harvester. A pair of circular blades cut the stalks at ground level and direct them toward chopping augars. The augers are equipped with fingers to pick up the cane, and the sharpened flights on the augers mesh together like scissor blades as they rotate to chop the cane into manageable pieces.

Before harvest, recumbent cane is burned to remove leaf trash. Green tops and suckers escape burning, however, and must be removed mechanically. The engineers found that a combination of roller-cleaners mounted on the rear of the conveyor could remove approximately one-third of the trash which remains in sugarcane after burning.

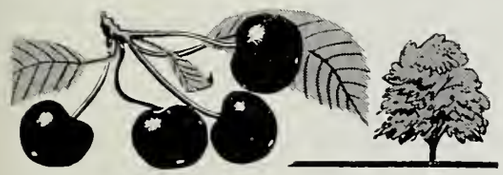
The proper speeds for these experimental devices were determined with the aid of high-speed photography, which allows the viewing of rotating devices through the heavy flow of cane.

This work is being done in cooperation with the Florida Agricultural Experiment Station. Principles and devices developed by ARS agricultural engineers are available to commercial manufacturers.■

AGRISEARCH NOTES

Introduced Cherry Disease Curbed

A new virus disease of sweet cherry was recently discovered in Utah, but no spread of the disease, named crinkle fruit, has been observed. All of the infected trees at Utah State University, where the disease was discovered, have been destroyed.



The virus that causes crinkle fruit moves very slowly through an infected tree, and the disease is recognized only by the fruit symptoms. This makes the infected trees difficult to detect for a long time after infection, particularly in trees propagated with infected buds.

ARS plant pathologist B. N. Wadley, working in cooperation with the Utah Agricultural Experiment Station, Logan, traced the virus disease to budwood that had been brought in by foreign students who had come to study at Utah State University in 1957. This budwood, which had not been introduced according to required plant quarantine procedures, was grafted by the students onto local sweet cherry trees. When the trees began producing fruit, the disease symptoms were noticed.

Crinkle fruit symptoms start as small, irregular-sized red spots on cherries. As fruit matures, the spots become bright red before color develops in the rest of the cherry. It appears that flesh beneath the spots stops growing, causing the crinkled surface. As the fruit develops color in ripening, colored spots are no longer visible, but the crinkled surface remains.

In 1967, a year after all infected trees had been destroyed, scientists conducted a careful survey in the vicinity where the disease had occurred, and none was found. This survey will be maintained in case the disease should reoccur.

Timing Winter Wheat Irrigation

In irrigation, just as in sports, it's timing that counts.

The most critical time to irrigate winter wheat is from the formation of the head through early grain development. This finding was made by ARS agricultural engineers A. D. Schneider and J. T. Musick and technician D. A. Dusek in studies on the Texas High Plains.

The scientists are studying the effects of irrigation timing on winter wheat yields in an effort to use the diminishing water supply more efficiently. More than 1,000,000 acres of winter wheat are under irrigation in the area, an increase of about 500,000 acres since 1956. At the same time, the water table has gone down almost 3 feet per year since 1962 because of ground-water pumping.

The researchers selected four stages of plant development for the study—early spring growth, booting (when the head begins to form), heading, and early grain development.

The study showed that less than normal amounts of moisture during the early spring did not affect yields appreciably if enough water was applied during the critical (booting through early grain) stage.

Every combination of irrigations—some 14, not including a control plot—was applied at the four selected dates so that effects of any series of applications could be evaluated.

Results show that where water is limited, one application can be better than two, two better than three, and three better than four if the applications are well-timed.

The study was conducted at the Southwestern Great Plains Research Center, Bushland, Tex., in cooperation with the Texas Agricultural Experiment Station.

Japanese Quail: Research Stand-Ins

Japanese quail have about the same genetic growth patterns as broiler chickens, making the smaller quail good stand-ins for chickens in genetic trials.

ARS poultry geneticists H. L. Marks and P. D. Lepore found that heritability of growth rate in two groups of quail was 38 and 48 percent. This puts them right in the middle of the 29 to 54 percent range established for heritability of growth rate in broilers. Marks is now using the quail to evaluate new methods of selectively improving growth rate of poultry.

Japanese quail already perform varied services in other types of poultry research. The quicker maturity, lower feed requirement, and reduced housing needs of the smaller quail saves researchers time and money.

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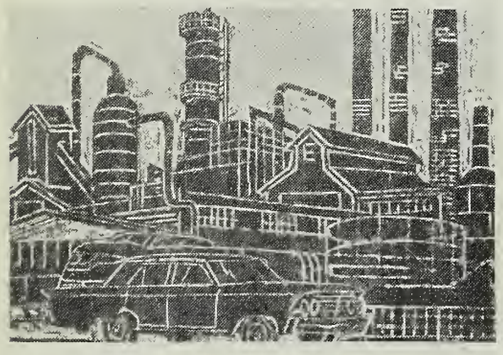
AGRISEARCH NOTES

Air Pollution and Plant Growth

Air as polluted as that found in ordinary greenhouses can cut the growth of very susceptible plants, like some tobacco varieties, by as much as 50 percent.



In order to measure the effects of exact amounts of major pollutants on plants, plant pathologist H. E. Heggestad, leader of ARS's Air Pollution Laboratory, Beltsville, Md., and his associates have developed two fumigation chambers and a special, pollution-free greenhouse.

The scientists modified standard growth chambers to make the fumigation chambers. With these, they are able to control temperature, humidity, and light when exposing plants to polluted atmospheres.

The pollution-free greenhouse utilizes carbon filters to eliminate most pollution from the air as it enters the greenhouse. One section of the new greenhouse does not have carbon filters, thus enabling scientists to make comparative studies between plants grown in clean, filtered air and those grown in the polluted air.

The fumigation chambers and pollution-free greenhouse will enable the scientists to contribute to the fund of basic knowledge about air pollution as well as to assist in identifying and developing pollution-resistant varieties of plants.

RF Treatments Improve Alfalfa

Exposing chopped alfalfa to radio-frequency electrical treatment increases carotene retention, thus improving the product as a feed.

Carotene is a pigment found in alfalfa and other plants. Animals convert it into vitamin A, a vitamin essential to the health of many body tissues.

In tests at the University of Nebraska, Lincoln, ARS researchers found that certain exposures to radio-frequency (RF) electric heating doubled the carotene content retained in chopped alfalfa after drying. Further investigation is necessary, however, before final conclusions can be drawn.

The researchers discovered the carotene retention effect while evaluating RF treatment as a possible means of field-drying alfalfa hay. At present, the practice would be uneconomical for drying hay to a safe storage moisture, because of the high power requirements.

If RF were made economically acceptable, however, ARS agricultural engineer L. E. Stetson says it could be valuable in field-drying alfalfa.

It eliminates the need for conductive or convective means of heat transfer and develops heat within material rapidly. The carotene retention effect is another plus factor.

Conducting the tests along with Stetson were ARS agricultural engineer S. O. Nelson and University of Nebraska biochemist R. L. Ogden.

Sugarcane Virus Control Facts

It is not feasible to control sugarcane mosaic virus with insecticides that kill the aphid vectors or herbicides that eliminate vector weed hosts in infected fields.

ARS plant pathologist Natale Zummo and entomologist L. J. Charpentier, in studies conducted at Houma, La., found that these control measures were not effective because aphids can be carried over long distances by air current. Infection can thus be brought from distant fields where insect vector and host weeds have not been controlled. In addition, the aphid vector can infect a plant treated with insecticide in the few minutes before the insect dies.

The study showed that aphids become infective within a few minutes after feeding on mosaic-infected sugarcane plants; they lose the ability to transmit the disease 1½ hours after feeding on the diseased plants.

The aphids remain infective only a short time, but long enough to infect several healthy plants. Also, they can become reinfective by feeding again on a diseased plant.

CAUTION: In using pesticides discussed in this publication, follow directions and heed precautions on pesticide labels. Be particularly careful where there is danger to wildlife or possible contamination of water supplies.

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